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(54) Combined step-stool and work-bench

(57) A step-stool includes front legs 10 and rear legs 11 supporting a top structure comprising a pair of rails 12 and a pair of vice members 90 and 92 which are normally concealed by a seat which can be folded to the position shown to form a horizontal tool tray 50 having an upwardly extending retaining flange 52.

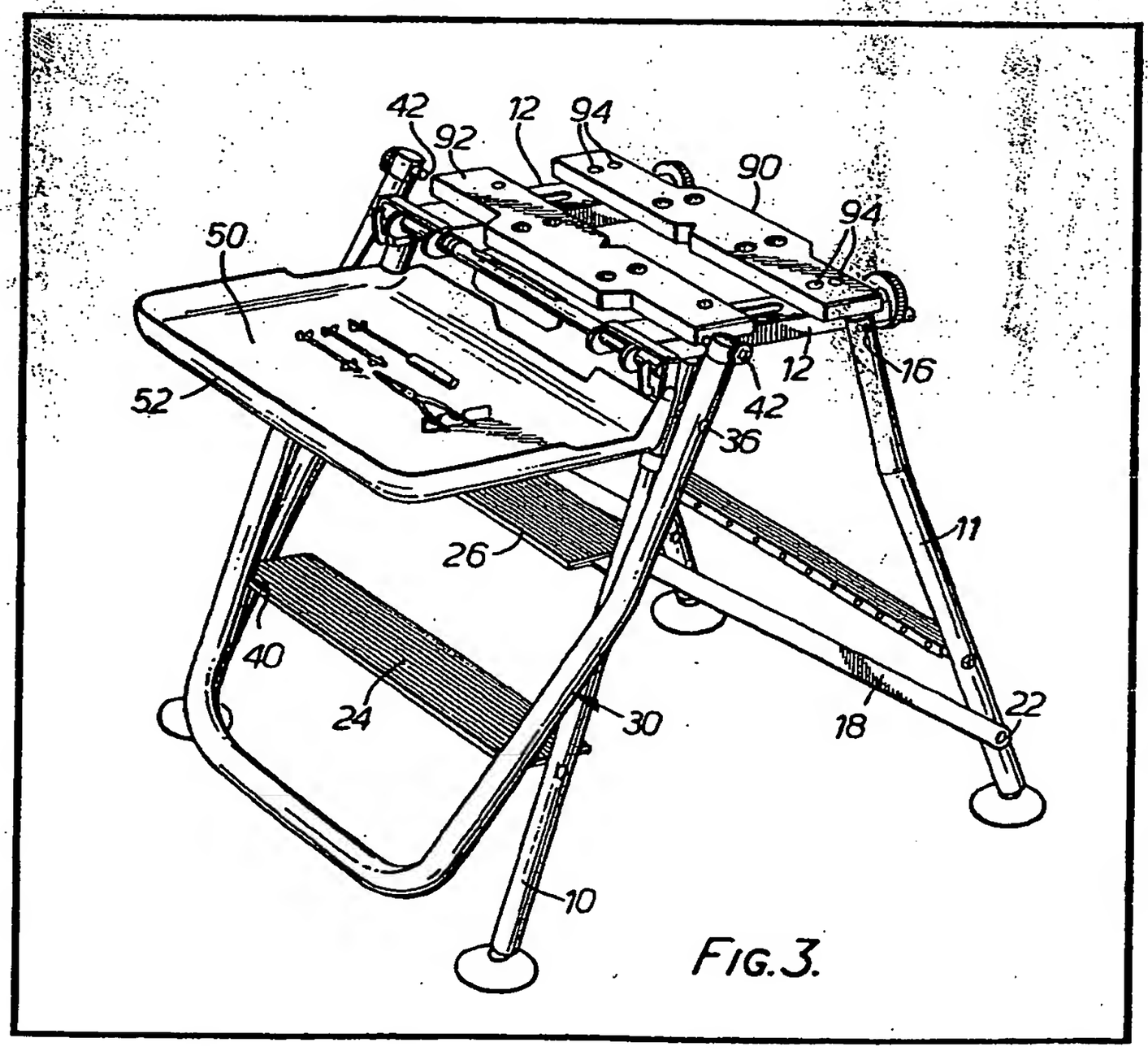

FIG.3.

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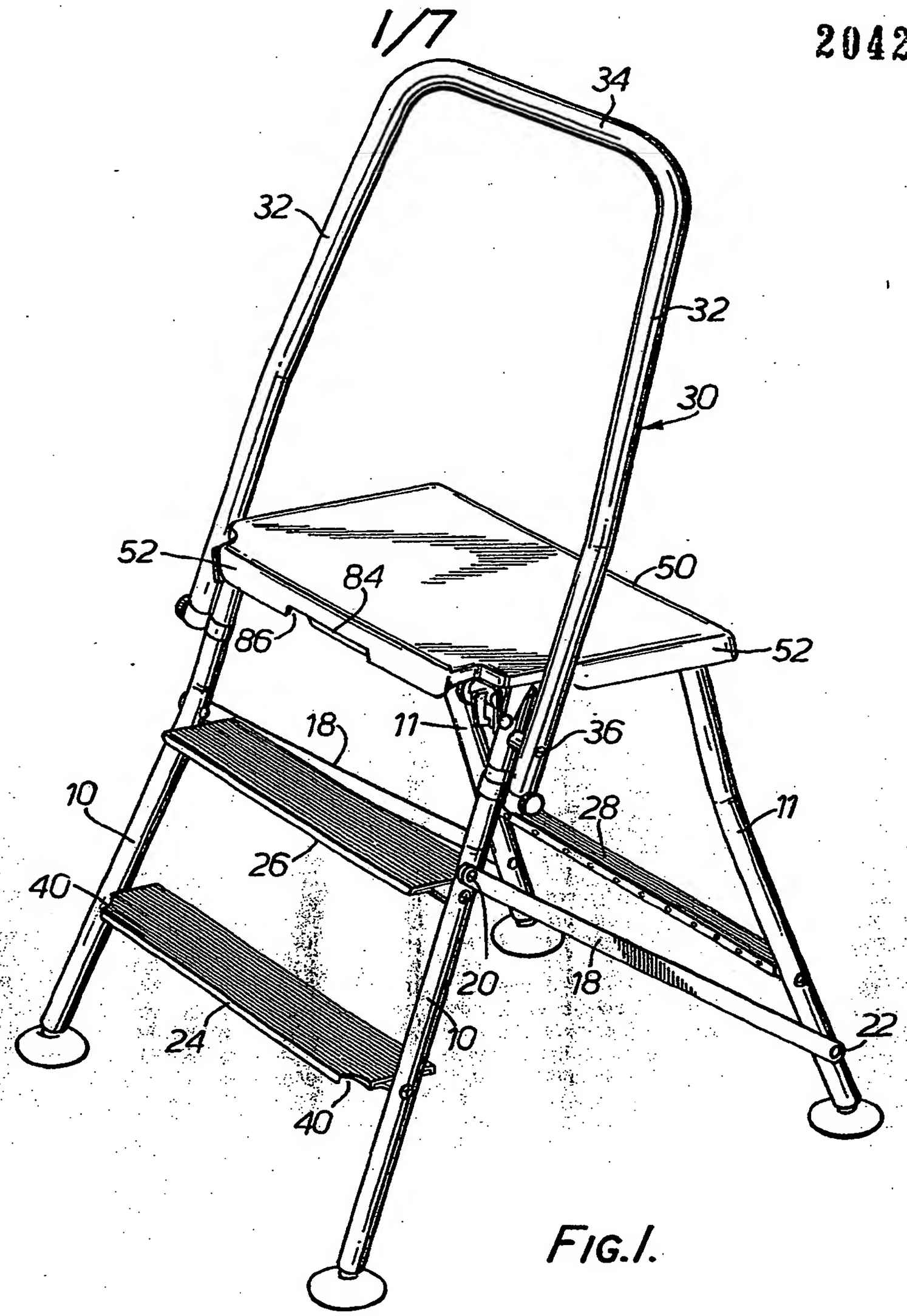

FIG.1.

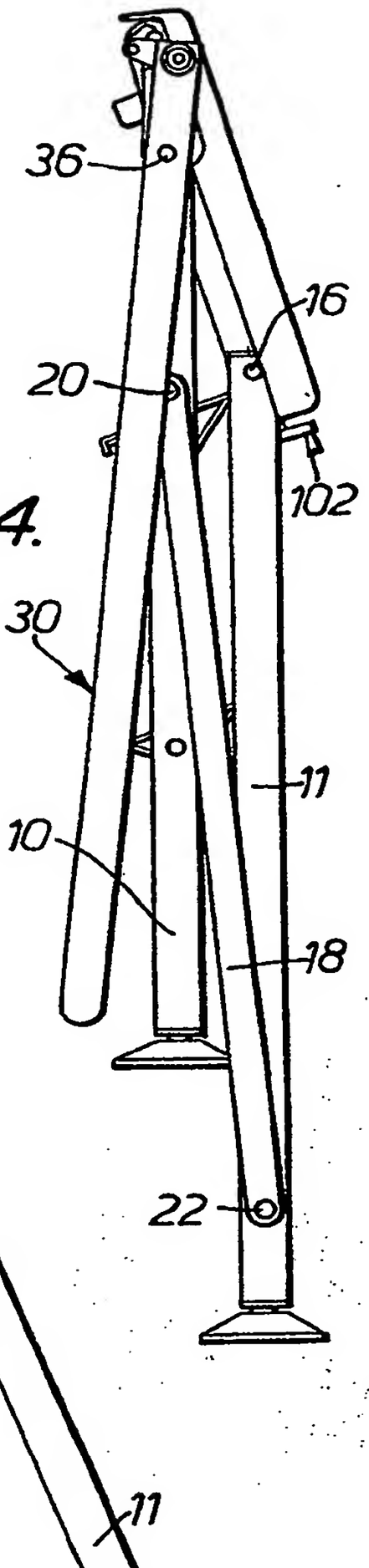

FIG. 4.

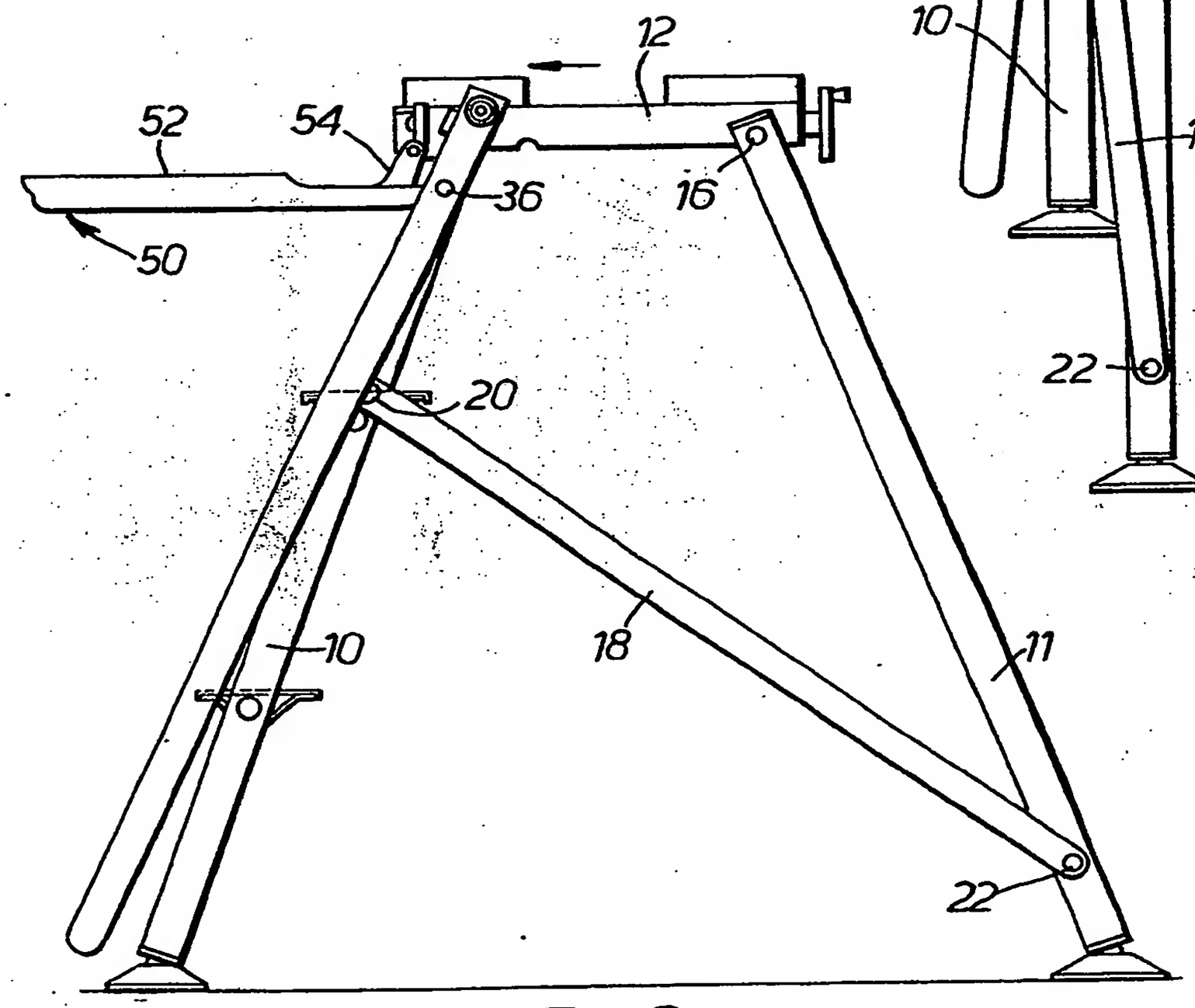

FIG. 2.

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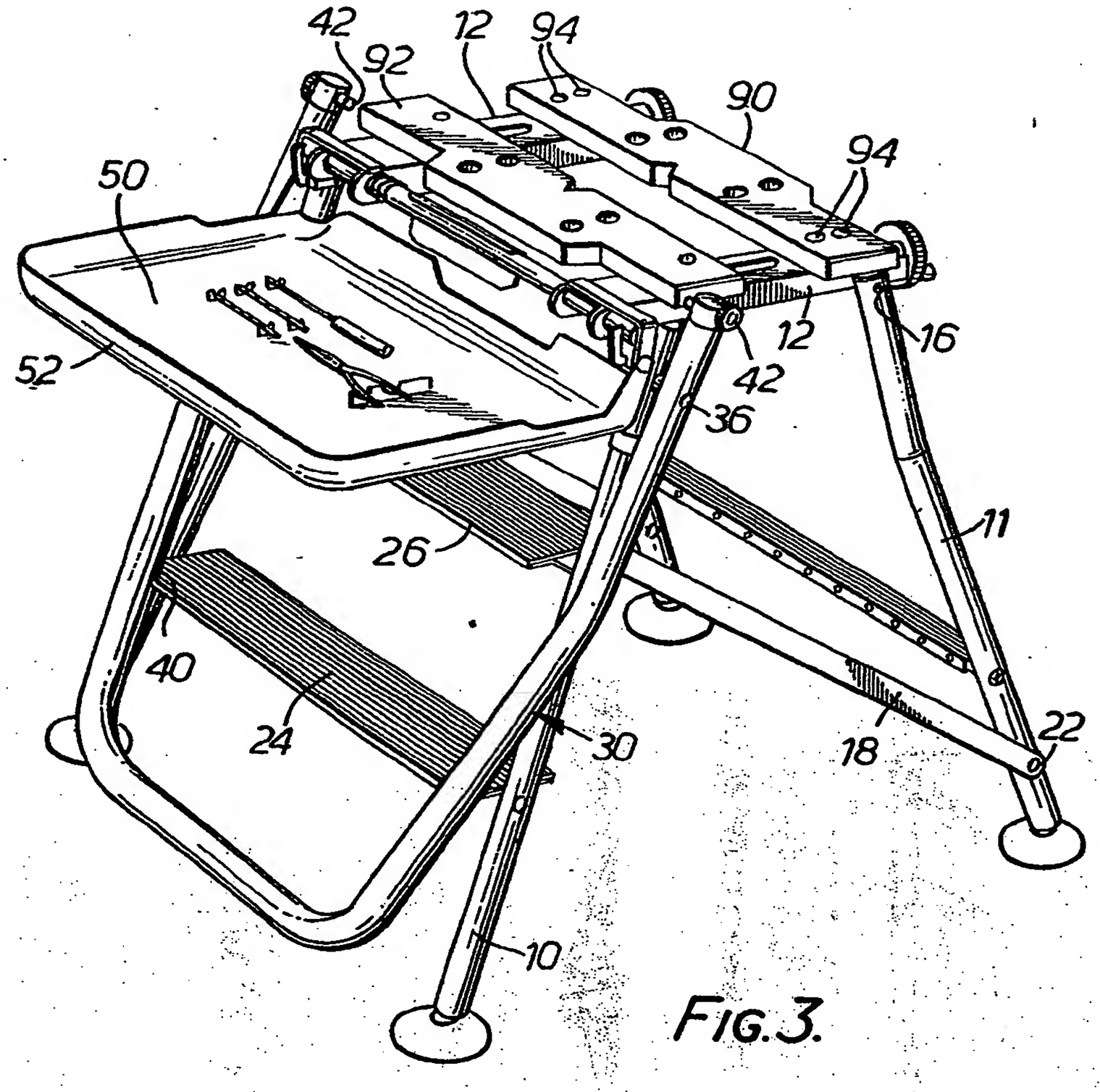

FIG.3.

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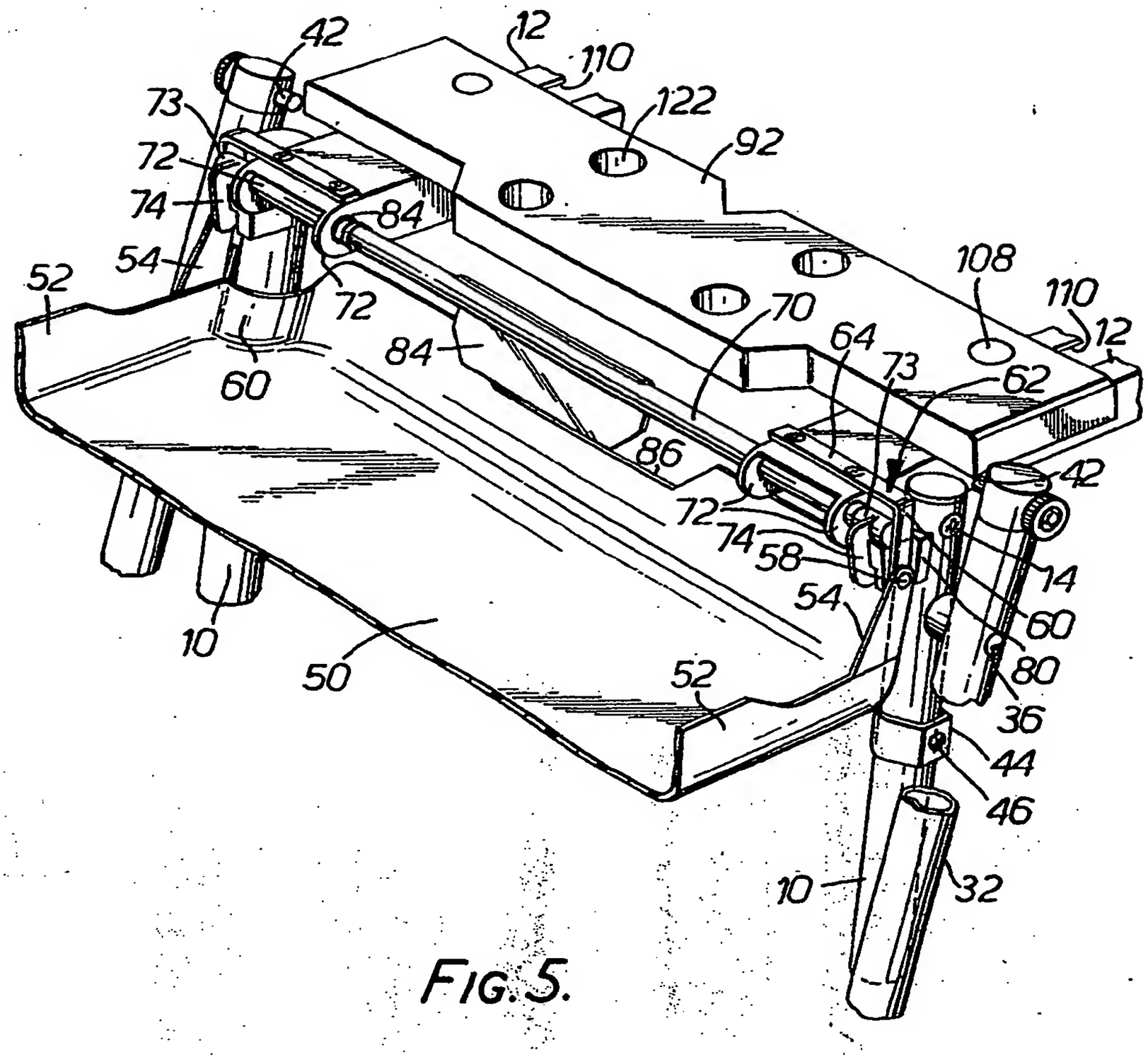

FIG. 5.

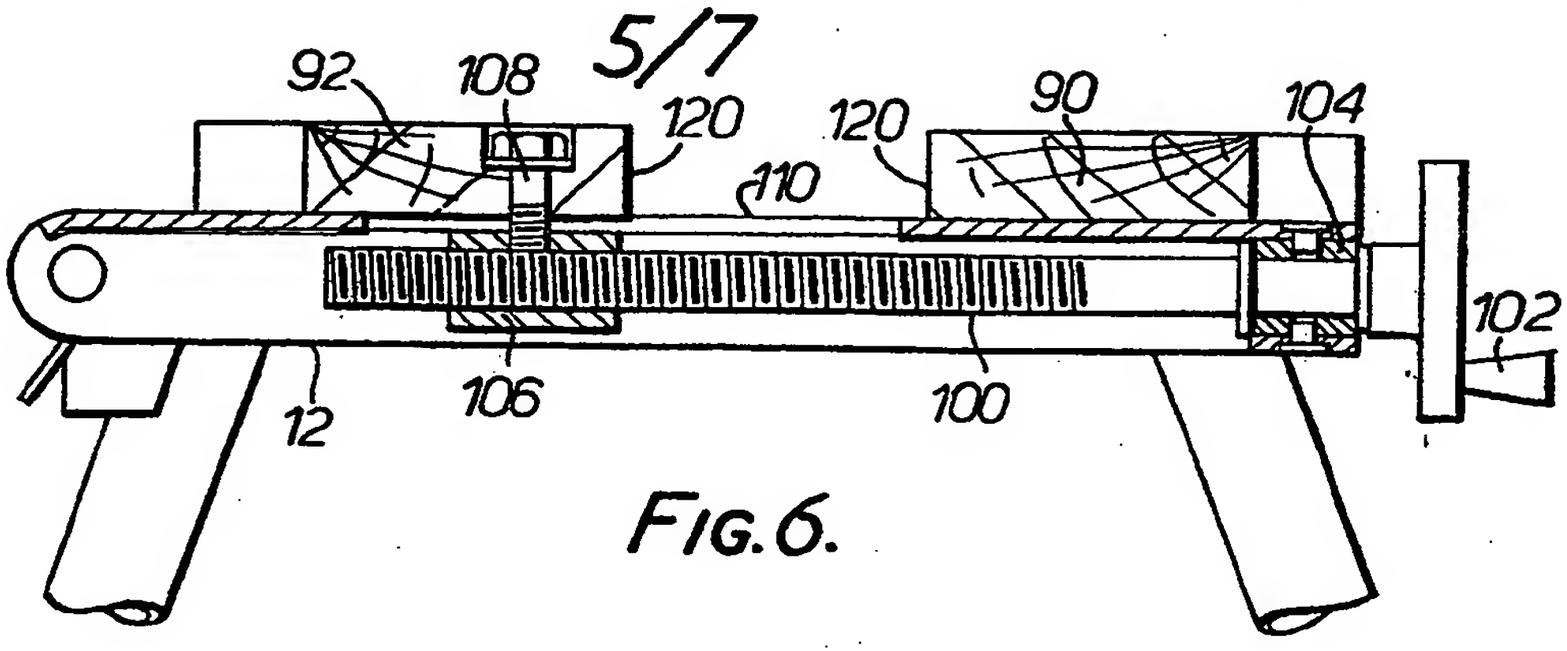

FIG. 6.

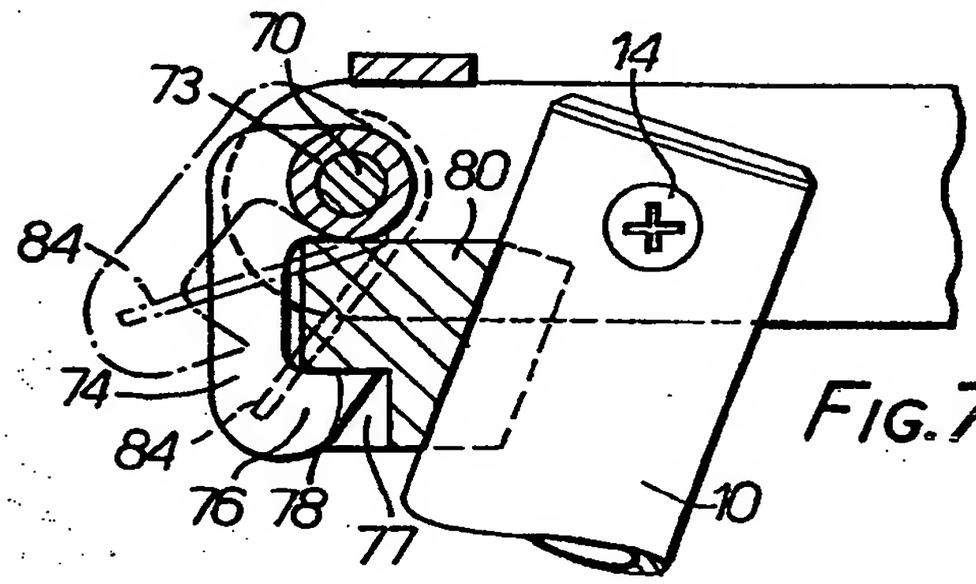

FIG. 7.

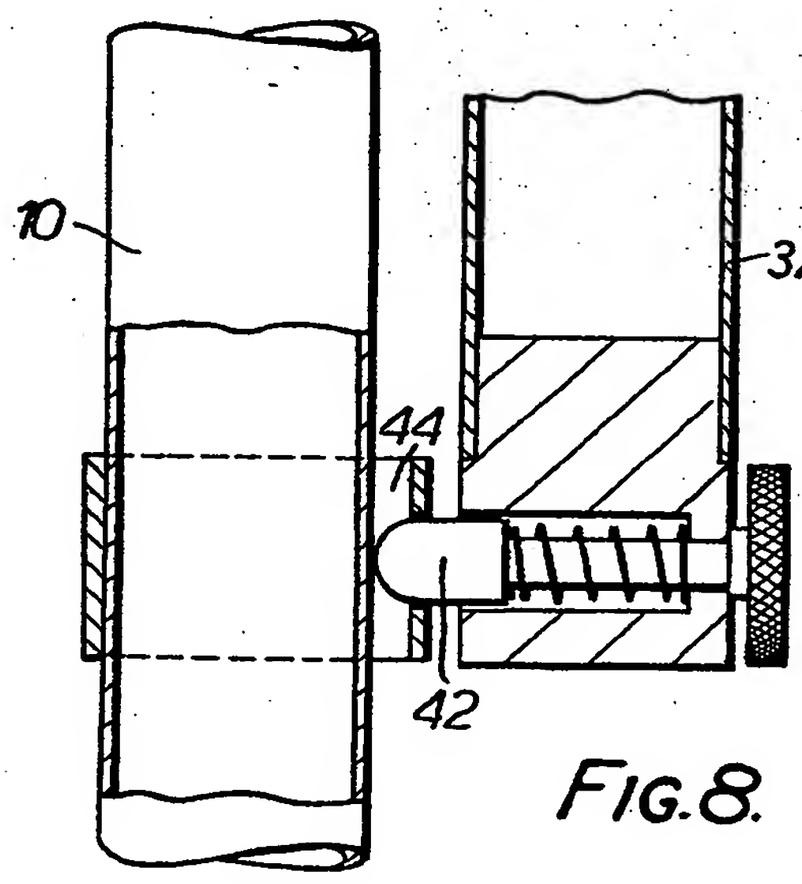

FIG. 8.

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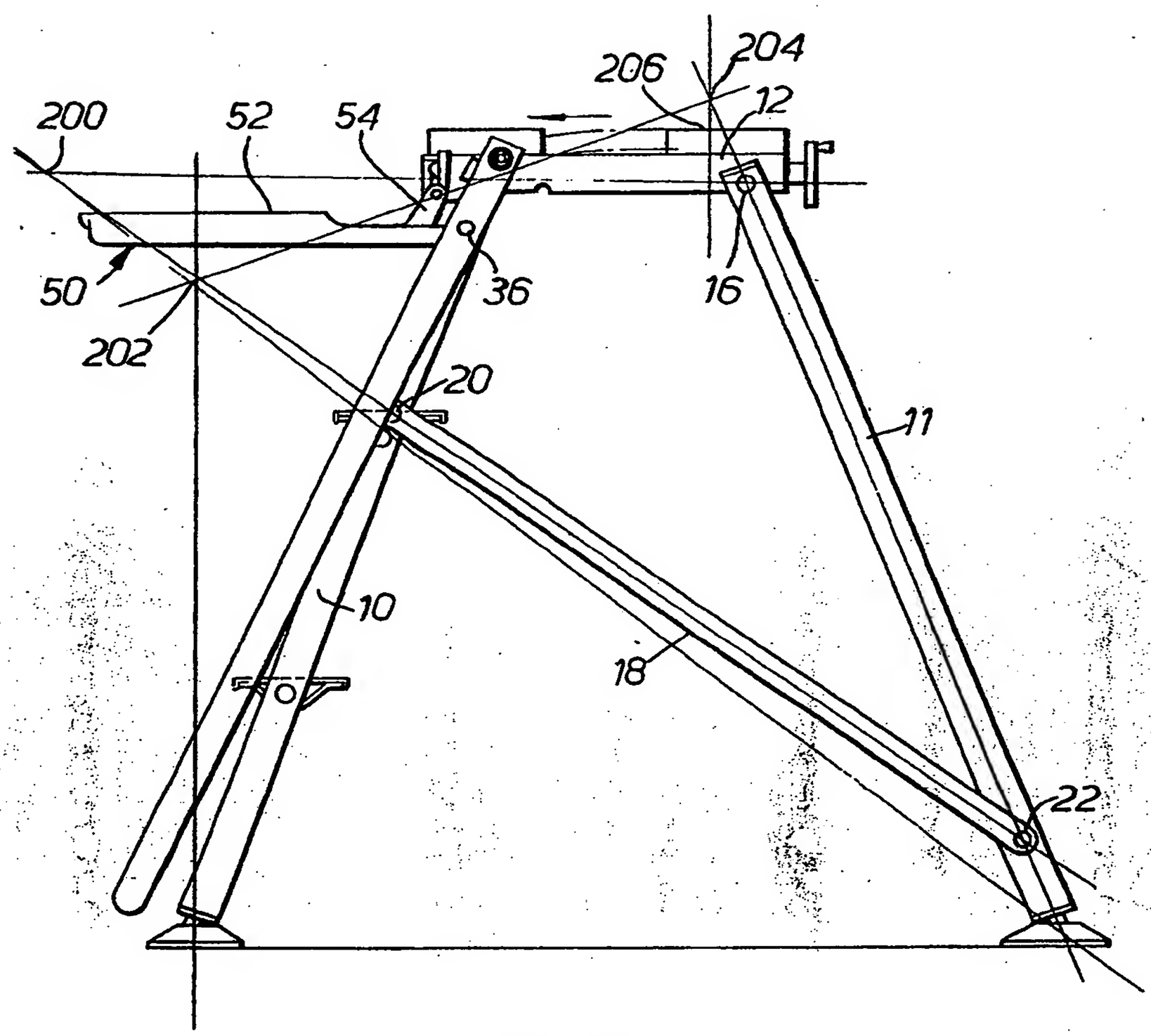

FIG. 9.

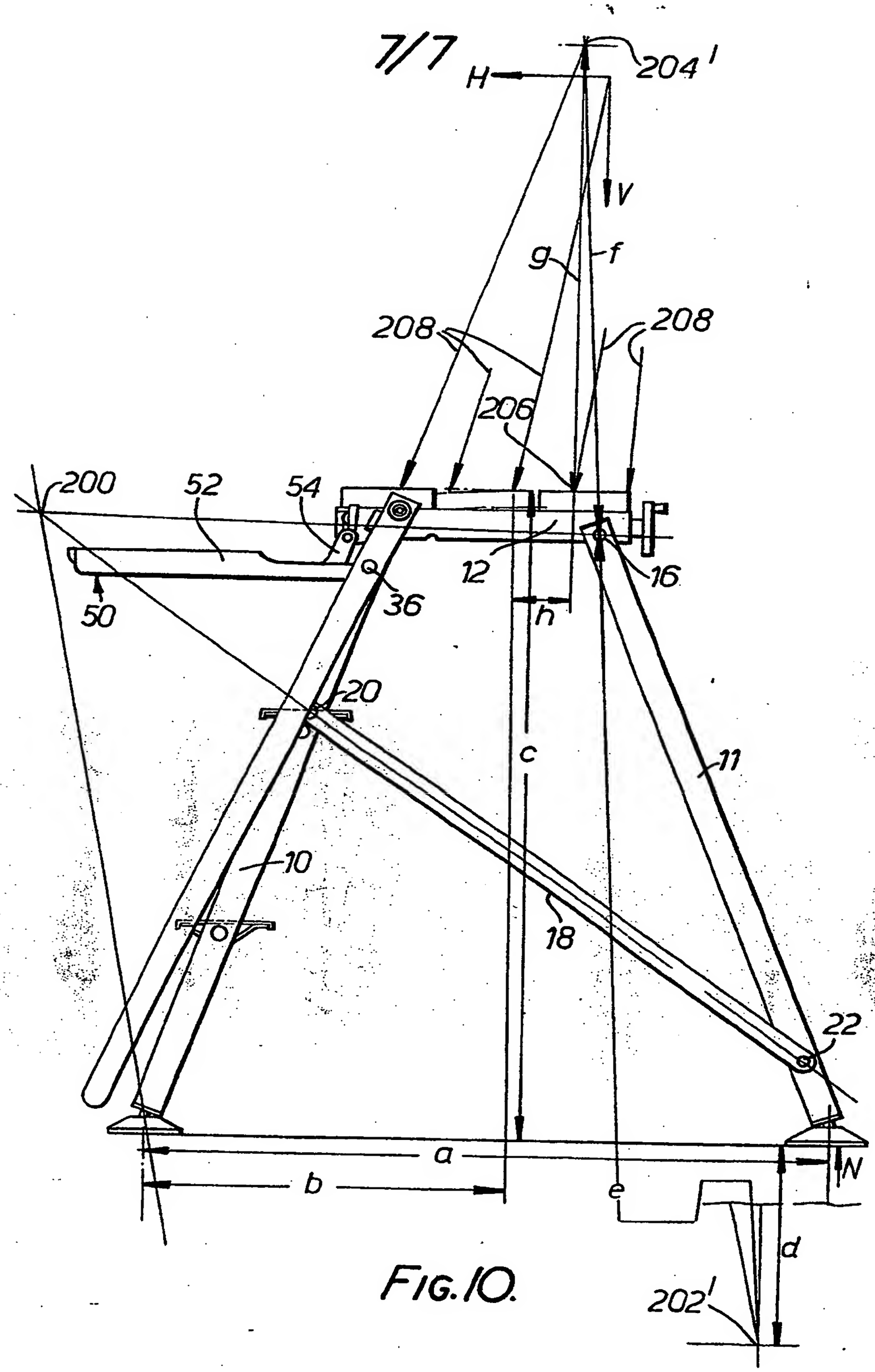
7/7
H
204'
V
g
f
208
208
206
200
52
54
12
16
50
36
h
20
c
11
10
18
22
a
b
e
N
d
202'

FIG. 10.

SPECIFICATION

Step-stool

This invention relates to step stools and more particularly to stools whose top surfaces can also be used as a working surface for carpentry and the like.

Several designs of step stools are already known and are often found in kitchens. In all cases, the step stool provides a seating surface which is usually cushioned and a flight of steps usually comprising two treads so that it is convenient to climb up the steps to stand on the seating surface, for example, to gain access to high cupboards. Usually, the step stool is collapsible in some way, for example, the whole stool may collapse to a flat form for storage, or the flight of steps may have a stowage position, out of the way beneath the seating surface of the stool.

According to the present invention, a step stool comprises a top structure and a supporting leg structure incorporating at least one step, the top structure including a vice unit comprising a pair of vice members having upper surfaces lying in substantially the same plane to form a working surface and vice operating means for positively shifting one vice member relative to the other, and a seat having a seat forming position in which it overlies and conceals a substantial part of the vice unit and an inoperative position in which the seat lies horizontally upside down adjacent the remainder of the top structure to form a tool tray.

The seat is preferably hinged for movement between its seat forming position and its inoperative tool tray-forming position and the seat may comprise a moulding having a flat seat-forming surface and a peripheral flange which extends downwards in the seat-forming position and upwards in the inoperative tray-forming position.

In a particular construction, the seat is connected to the top structure by cranks which position the tray at a lower level than the seat. Abutment means on the tray and at least one leg may prevent movement of the seat beyond its tray-forming position.

Desirably, in order to prevent users climbing onto the top structure when the vice unit is exposed, the seat preferably lies over the step when forming the tool tray.

The tool tray may incorporate a tool store which, when the seat is in the seat forming position, lies in the gap between the vice members. In this case, the seat may be supported partially by each vice member.

The vice unit may include a pair of rails extending from front to rear and supporting the vice member, the seat being hinged to the ends of the rails.

The invention may be carried into practice in a number of ways but one specific embodiment will now be described by way of example, with reference to the accompanying drawings, in which:–

Figure 1 is a perspective view from above and one side of a work unit formed in accordance with the present invention, and shown in its step ladder mode;

Figure 2 is a side elevation of the unit of Fig. 1, with its handrail in a stowed position and its seat folded outwards to form a tool tray, the unit in Fig. 2 being it its workbench mode;

Figure 3 is a perspective view corresponding to Fig. 2;

Figure 4 shows the unit in a partially folded condition;

Figure 5 is an enlarged persepective view of certain parts of the work unit including the latching mechanism;

Figure 6 is a sectional side elevation showing the mechanism by which the work top vice of the unit operates;

Figure 7 is a scrap view in side elevation of the latching mechanism which prevents the unit folding;

Figure 8 is a view of one of two latches for the handrail;

Figures 9 and 10 show the location of certain of the instantaneous centres of relative rotation as the work unit begins to fold; Fig. 10 also illustrates how inclined forces applied to the work unit may tend to cause it to fold.

The work unit shown in the drawings has three distinct modes of use, namely, as a step ladder when a handrail is raised as in Fig. 1, as a small workbench when a seat is unfolded to form a tool tray as shown in Fig. 2 and as a step-stool when the seat is returned to its normal position.

The unit incorporates a pair of front legs 10, and a pair of rear legs 11. The upper ends of the legs 10 and 11 are pivotally connected to a pair of spaced rails 12, which form part of a top structure, the rails 12 each being of inverted U form. The front legs 10 are connected to the rails 12 by means of pivotal connections 14, of which one is shown in Fig. 5, whilst the rear legs 11 are connected to the rails 12 by means of pivotal connections 16 of which one is shown in Figs. 3 and 4. The front leg 10 and the rear leg 11 on each side are connected by respective braces 18, which braces are pivotally connected to the legs 10 and 11 by means of pivotal connections 20 and 22 respectively. In order that the unit can fold to the configuration shown in Fig. 4, in which the legs 10 and 11 are substantially parallel, the sum of the dimension between the pivots 14 and 16 plus the dimension between the pivots 16 and 22 is substantially equal to the sum of the dimension between the pivots 14 and 20 plus the dimension between the pivots 20 and 22.

The front rails 10 are interconnected by a pair of spaced steps, namely a lower step 24

at a height of 200mm and an upper step at a height of 400 mm.

The rear legs 11 are interconnected by a single horizontal rail 28 at a height of 180 mm which provides a ready means for stabilising the unit when in its workbench mode. Each of the steps 24 and 26 and the rail 28 are provided with a ribbed tread surface.

Associated with the front legs 10 is a U-shaped handrail 30 having a pair of limbs 32 interconnected by a cross member 34. The handrail 30 is pivotally mounted on the front legs 10 by a pair of pivotal connections 36 positioned slightly below the pivotal connections 14 of the front legs 10 to the rails 12. Figs. 2,3,4 and 5 show the handrail 30 in an inoperative stowed position in which it lies slightly in front of the lower parts of the front legs 10. It will be observed that the handrail 30 is slightly narrower adjacent the cross member 34 and in order to accommodate this narrow part of the handrail in the stored position, the lower step 24 has a pair of cut out corners 40 shown most clearly in Fig. 1.

The free ends of the limbs 32 of the handrail 30 extend slightly beyond the pivotal connections 36 and have at their extremeties latching mechanism in the form of spring loaded plungers 42 for securing the handrail in its operative position of Fig. 1. As is most clearly shown in Fig. 5, the front legs 10 each carry an abutment 44 having in it a hole 46 to accommodate the appropriate plunger 42 when the handrail is in its operative position.

The unit incorporates a moulded seat 50 having a depending flange 52. As shown in Fig. 5, at the front end of each side portion of the flange 52, the flange has secured to it a bracket 54, an end of which is connected by a pivotal connection 58 to a vertical limb 60 of an inverted-L-shaped bracket 62, the other horizontal limb 64 of which is secured to the front end of one of the rails 12. The seat also forms a top step or platform for the step ladder mode at a height of 608mm. The platform is 250mm in depth and 370mm in width. In this manner, the seat 50 can be unfolded from its operative seat-forming position of Fig. 1 in order to uncover a worktop vice which will be described in detail later. In its unfolded position, the seat 50 lies horizontally, as shown in Figs. 2,3, and 5 to form a tool tray. The tray includes a number of tool retaining clips as shown in Fig. 3. The seat has a pair of moulded indentations 60 which nest with the upper ends of the front legs 10 when the seat is forming a tray, as shown in Figs. 3 and 5, the indentations effectively providing abutments to prevent further rotation of the seat beyond its horizontal tray-forming position.

Referring now to Fig. 5, extending from side to side, across the upper end of the unit, is a transverse rod 70 which is journalled in the forward ends of vertical limbs 72 of the rails 12.

The ends of the rod 70 each rigidly carry a collar 73 having a downwardly extending hook 74 of the detailed form shown in Fig. 7. A hooked end 76 of each hook 74, in the erect condition of the unit, engages under an abutment surface 78 of an abutment block 80 secured to the upper end of the front leg 10 on that side. By means of a small coil spring 84, the rod 70 is biassed in a rotary direction to engage the hook 74 with the abutments 80. This effectively maintains the hooks in their latched positions in which they prevent collapse of the unit by folding about the pivots 14, 16, 20 and 22. Such folding would otherwise tend to occur when certain loads are applied to the top of the unit.

The unfolding movement of the unit is limited at the erect position of the legs by engagement of the abutment blocks 80 with the ends of the rod 70.

The hooks have cam surfaces 77 which bias the hooks to an open position as the unit is unfolded, but as soon as the hooks clear the abutment surfaces 78, the coil spring 84 biases the hooks into their engaged positions. The latches formed by the hooks, apart from preventing collapse during use, also maintain the structure erect if it is lifted, say by its erect handrail. The fact that the surface 78 of the latch is formed on the abutment block 80 and the hooks 74 are formed on the collars 73 which abut against the blocks 80 makes for considerable simplicity and assist in overcoming tolerance problems which exist when trying to ensure that two parts abut to form a stop (the collars 73 and the blocks 80) simultaneously with the engagement of the latches.

Figs. 9 and 10 help to illustrate why such collapse may tend to occur. The geometry of the folding parts of the work unit dictates that the feet of the front legs 10 will move towards the feet of the rear legs 11 as the work unit begins to fold, so that some sliding of one or other of the sets of feet must occur. If the feet of the front legs 10 slide, while the feet of the rear legs 11 remain stationary, the centre of rotation of the front legs relative to the rear legs adopts the position shown at 200; the centre of rotation of the front legs 10 relative to the floor adopts the position shown at 202; and the centre of rotation of the top of the work unit relative to the floor, adopts the position shown at 204, all as shown in Fig. 9. Alternatively, if the feet of the front legs 10 remain stationary, while the feet of the rear legs 11 slide, the position of the centre of rotation of the front legs relative to the rear legs remains at 200; the centre of rotation of the rear legs 11 relative to the floor will adopt a position shown (diagrammatically only, because of its considerable distance from the other centres) at 202′ in Fig. 10; and the centre of rotation of the top of the work unit relative to the floor will adopt

the position shown at 204′, all as shown in Fig. 10. From a comparison of Figs. 9 and 10, it can be seen that the horizontal position of the centre of rotation of the top of the work unit is the same in either case; it lies above a point 206 close to the rear of the top structure.

If friction between the feet and the floor is neglected, it can be seen that a pure vertical force applied to the top of the work unit at a point forward of the point 206 will tend to rotate the top anticlockwise, as seen in Fig. 9; such rotation corresponds to a movement in the sense from a folded condition to an erected condition, and therefore such a force will merely tend to hold the work unit more firmly in its erected condition. Conversely, a pure vertical force applied to the top of the work unit to the rear (i.e. to the right) of the point 206 will tend to rotate the top clockwise, collapsing the unit; such collapsing is however prevented by the hooks 74.

In the foregoing, friction between the feet and the floor is neglected, the effect of such friction will be that, even without the hooks 74, there would in practice be no danger of the work unit being collapsed by a pure vertical force. However, in some circumstances, a vertical force may be combined with a force directed forwardly (to the left in Fig. 10) and this will produce a stronger tendency for the work unit to collapse, since the top of the work unit shifts forwards as collapsing occurs (assuming that all the feet remain in contact with the floor). The presence of a forwardly directed force will mean that, in collapsing, the rear feet of the work unit slide forwards, rather than the front feet sliding rearwards and therefore the centres of rotation will adopt the position of Fig. 10.

If the self-weight of the work unit is neglected, and the force applied to the top of the work unit is considered as comprising a vertical component V and a horizontal component H, the vertical reaction N at the rear feet will be given by the following equation:

$$N.a = V.b - H.c \qquad (1)$$

where, as shown in Fig. 10, a is the span between the front and rear feet; b is the horizontal distance from the front feet to the point of application of the force; and c is the vertical distance from the front feet to the point of application of the force.

For the slipping of the rear feet to just begin, the work done by the two force components as the top of the work unit moves must just equal the energy absorbed by friction at the rear feet. For a small movement δ of the rear feet, it can be shown that the point on the top of the work unit to which the force components H and V are applied will move horizontally by a distance

$$\delta_H = \frac{\delta\, e\, g}{d\, f} \qquad (2)$$

where, as shown in Fig. 10, d is the distance from the point 202′ to the rear feet; e is the distance from the point 202′ to the pivot 16; f is the distance from the pivot 16 to the point 204′; and g is the vertical distance from the point 204′ to the point of application of the force.

Similarly, the point of application of the forces will shift vertically by a distance

$$\delta_V = \frac{\delta\, e\, h}{d\, f} \qquad (3)$$

where h is the horizontal distance between the point 206 and the point of application of the force; if the latter point is forward of the former, this will result in an upward movement, and an upward δ_V will be taken as positive.

If the coefficient of friction at the rear feet is μ, then, for slipping just to begin,

$$\mu N\delta = H.\delta_H - V\delta_V \qquad (4)$$

Equations (1) to (4) can readily be solved to give a value for the maximum ratio of H to V, for each possible point of application of force to the top of the work unit. The arrows 208 in Fig. 10 show the positions of the lines of action of a number of forces which are just sufficiently inclined to initiate collapsing of the work unit in the absence of the hooks 74, for a coefficient of friction of 0.3. As can be seen, most of these lines of action pass appreciably to the right of the point 204′, since a definite clockwise moment about this point is required to overcome friction and initiate collapse. However, the most leftward of the illustrated lines of action passess through the point 204′, since a force applied along this line will be borne entirely by the front feet, and will not create any friction at the rear feet.

When it is desired to fold the unit, the hooks 74 can be very simply released by means of an upward and forward force applied to a release member 84 secured to the central portion of the rod 70. Such release will normally occur when the seat 50 is in the operative position of Fig. 1 at which time access can be had to the release member 84 via a notch 86 formed in the flange 52 of the seat 50.

The vice which forms the top of the work unit will now be described. It includes a fixed, rear, elongate vice member 90 and a movable front vice member 92. The fixed vice member 90 is secured to the rails 12 by pairs of bolts 94 and, with the rails 12, forms a U-shaped top structure of considerable rigidity. Refer-

ring to Fig. 6, extending within each of the U-shaped rails 12 is a vice operating screw 100 having at its rear end an operating handle 102. Adjacent the handle, the screw 100 is mounted in a journal bearing 104 secured in the rail 12. The screw 100 carries a nut 106 having a bolt 108 extending vertically upwards therefrom through a slot 110 in the horizontal web of the rail 12, the bolt connecting the nut 106 to the movable vice member 92, to form a vertical pivotal connection which enables arcuate movement of the movable vice member 92 to occur during independent operation of one vice screw 100 without operation of the other vice screw. In this manner, the vice can be readily operated by a user holding a workpiece in one hand between the vice members and alternating the operation of the handles 102. This facility also enables the clamping of tapered workpieces between the clamping faces 120 of the two vice members.

The presence of the tool retaining clips, on the underside of the seat makes it necessary to open the vice members to substantially their full spacing in order to allow the clips between them. This has the advantage that the movable vice member 92 is then in a good position partially to support the seat from its underside. The seat is also supported by the stationary vice member 90 at this time.

It is to be noted that in its workbench mode of Fig. 3, both the handrail and the tool tray are well below the upper level of the vice members to provide unobstructed access thereto.

The height of the top of the handrail in its operative position is 1080mm which is at a convenient height in relation to the rest of the structure for a user when standing on the seat 50 to rest his or her knees against the handrail.

Each vice member has in its four spaced vertically extending bores 122 to receive plug-in attachments of the type described in British Patent No. 1,422,521, to enable workpieces wider than the maximum gap between the work faces 120 to be accommodated and also to enable workpieces of irregular shape to be clamped by the vice.

The work unit described is ideally suited for use in the home and has three main functions, namely, a step-stool, a step ladder or a miniature workbench. It can be readily converted from one to the other in a matter of moments and also can be stored away in a small storage space simply by folding to the configuration of Fig. 4. It is to be noted however that the unit can be collapsed to storage condition, with the handrail in its raised position if required. The unit is extremely stable when erected due to the forward and rearward inclination of the front and rear legs, and also due to the lateral splay of the lower part of the legs.

From its collapsed configuration of Fig. 4, the unit can be readily erected simply by resting the feet of the rear legs on the floor and allowing the front legs and seat structure to fold downwards automatically.

It is to be noted that when the seat is unfolded to form a tool tray, the tray effectively blocks access to the steps so that there is little risk of a user attempting to use the unit as a step-stool whilst the vice unit is uncovered.

CLAIMS

1. A step-stool comprising a top structure and a supporting leg structure incorporating at least one step, the top structure including a vice unit comprising a pair of vice members having upper surfaces lying in substantially the same plane to form a working surface and vice operating means for positively shifting one vice member relative to the other, and a seat having a seat forming position in which it overlies and conceals a substantial part of the vice unit and an inoperative position in which the seat lies horizontally upside down adjacent the remainder of the top structure to form a tool tray.

2. A step-stool as claimed in Claim 1 in which the seat is hinged for movement between its seat forming position and its inoperative tool tray forming position.

3. A step-stool as claimed in Claim 1 or Claim 2 in which the seat comprises a moulding having a flat seat forming surface and a peripheral flange which extends downwards in the seat forming position and upwards in the inoperative tray forming position.

4. A step-stool as claimed in Claim 2 in which the seat is connected to the top structure by cranks which position the tray at a lower level than the seat.

5. A step-stool as claimed in Claim 2 including abutment means on the tray and at least one leg to prevent movement of the seat beyond its tray forming position.

6. A step-stool as claimed in any one of the preceding claims in which the seat lies over the step when forming the tool tray.

7. A step-stool as claimed in any one of the preceding claims in which the tool tray incorporates a tool store which, when the seat is in the seat forming position, lies in the gap between the vice members.

8. A step-stool as claimed in Claim 7 in which the seat is supported partially by each vice member.

9. A step-stool as claimed in Claim 2 in which the vice unit includes a pair of rails extending from front to rear and supporting the vice members, the seat being hinged to the ends of the rails.

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